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SECTION OF GEOLOGY AND MINERALOGY*

MAY 7, 1945

DOCTOR LEWIS B. KELLUM, Director, Museum of Paleontology, University of Michigan, Ann Arbor, Michigan: *Jurassic Stratigraphy of Alaska and Petroleum Exploration in Northwest America.* (This lecture was illustrated with lantern slides.)

The bearing of the Jurassic stratigraphy of southwestern Alaska on the petroleum possibilities of northwestern America stems from the events of geologic history recorded in the rocks. The faunal zones recognized in stratigraphic sections of near shore marine deposits dates the orogenic, physiographic and climatic changes taking place on nearby lands and in the neritic belt. Source and reservoir rocks in the sections can be projected into the subsurface of nearby areas where the cover is sufficient to permit accumulation of hydrocarbons. Precise age determination of the rock units within the formations permits the recognition of structural features which may influence the migration of hydrocarbons. The accurate correlation of strata in southwestern Alaska with those of the Pacific coast and Rocky Mountain region of Canada and the western United States by means of the faunas, integrates the geologic events throughout northwestern America, highlights the oil producing horizons of one area for intensive study in distant

* No meeting of the Section of Anthropology was held in May.

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TABLE 1

TENTATIVE COMPOSITE TRIASSIC AND JURASSIC STRATIGRAPHIC SUCCESSION IN SOUTHWESTREN ALASKA

Period	Formation	Lithology	Faunas
Upper Jurassic		White or light-colored, hard arkosic sandstone, andesitic tuff, coarse and fine sandstone, shale and conglomerate. Thin sills of quartz diorite are intruded into the sedimentary beds. 3000+ feet.	*Aucella*
	Naknek 5000′	Gray shale with dark arkosic beds. At the base is fine conglomerate or grit with thin sandy beds scattered through it, equivalent to the Chisik Conglomerate. 1645 feet.	*Cardioceras*
		Chisik Conglomerate: Locally developed; 290′–400′. Boulders of granite or diorite and other igneous rocks embedded in tuffaceous andesitic matrix.	
	Shelikof 8000′	Massive black shale with some limestone lenses and nodules. 700–1000 feet.	
		Massive brown to gray sandstone with minor amounts of shale and conglomerate. 4000–4700 feet.	*Astarte* sp. E
		Gray sandy shale. 200 to 1200 feet.	
		Chinitna shale member: Gray shale with stringers of fine and coarse sandstone and buff-weathering limestone; large limestone concretions weathered ashy gray at one horizon carry fossils. A thin porphyry sill intrudes this section at Wide Bay. 400–1300 feet.	*Cadoceras*
		Well-stratified gray shale interbedded with thin lenticular layers of limestone and thin beds of soft gray sandstone weathered yellow; limestone concretions varying from 1 to 10 feet in longest dimension contain wood fragments and a large flat *Inoceramus*. Several diabase sills intrude these strata at Wide Bay. 950 feet.	
		Interbedded sandy shale and fine to medium grained silty sandstone containing gray limestone concretions. 100 ± feet.	*Seymourites*

TABLE 1 (Continued)
TENTATIVE COMPOSITE TRIASSIC AND JURASSIC STRATIGRAPHIC SUCCESSION IN SOUTHWESTERN ALASKA

Period	Formation	Lithology	Faunas
Upper Jurassic	Tuxedni 4000′	Tonnie sandstone member: a series of alternating sandstones, shales and coarse conglomerates with numerous fossil bearing horizons. 1200 feet.	*Miccocephalites*
Middle Jurassic		Sandy shale with stringers of shaly sandstone; near the middle are coarse sandstones grading into conglomerates with cobbles of volcanic rock; small calcareous concretions in the shale near the base are fossiliferous. 950 feet.	*Oppelia* sp. C
		Cynthia Falls member: Medium-grained gray sandstone grading horizontally into alternating sandstone and conglomerate. 800 feet.	
		Sandy shale with numerous stringers of shaly sandstone and with concretionary masses in the upper half; fossils present at many horizons. 1250 feet.	*Defonticeras* sp. B *Zemistephanus*
Lower Jurassic	Kialagvik 1600′	Kolosh member: (a) Platy to massive medium-grained to conglomeratic greenish-gray sandstone containing wood fragments and *Inoceramus*. 200 feet.	*Inoceramus* sp. C
		(b) Interbedded sandstone and shale becoming predominantly sandstone at the top. 300 feet.	*Dactylioceras*
		Aleuts member: (a) Interbedded sandstone, shale and conglomerate, increasing in coarseness upward with several beds of conglomerate in the upper 200 feet. 450 feet.	*Hammatoceras? kialagvikense*
		(b) Dark gray to black shale grading upward into gray shaly sandstone. 650 feet.	*"Hammatoceras" howelli*
	Bidarka 2300′	Dark gray-black shale with occasional thin beds of light colored, coarse-grained, well-indurated sandstone. 1300 feet.	*Arieticeras?*
		Massive to thin-bedded tuffaceous sandstone and interbedded calcareous shale and limestone. 1000 feet.	*Astarte* sp. D
Upper Triassic	Kamishak 1400′	Thin-bedded, dense, organic limestone interbedded with shale and sandstone; intruded by dikes and sills.	*Pseudomonotis subcircularis*

potentially productive areas, and shows the extent and distribution of synchronous seas, the position of their shorelines, their hinge lines of subsidence and their basins.

The sequence of Jurassic and Triassic formations in southwestern Alaska is shown in TABLE 1.

The Kamishak formation exposed at Cold Bay is dominantly limestones and may be considered favorable source rocks for petroleum. Their apparent organic character is also encouraging. The limestones are not greatly metamorphosed and the few igneous dikes and sills which penetrate them have produced only narrow zones of alteration. These intrusions are thought to be of pre-Jurassic age, since they are confined to the Triassic rocks. The overlying Jurassic strata are free from intrusives in the Cold Bay section. The gradational and apparently conformable contact between the Triassic and Jurassic systems in this section indicates that there was no period of folding, uplift and erosion after the Triassic limestones and associated sandstone had been deposited. Such an unconformity, if present, might have afforded the opportunity for escape of liquid hydrocarbons which had accumulated in the Triassic rocks before Jurassic time. On the other hand, many if not most large accumulations of oil throughout the world are associated with unconformable contacts. Tuffaceous sandstones in the upper part of the Triassic section furnish possible reservoirs for the accumulation of oil formed in the limestone and shale source rocks. The objective of any deep well drilled in the Alaska Peninsula should be to penetrate the Triassic rocks from top to bottom. It is perhaps significant, however, that the Triassic throughout the world has produced less oil than any other post-Cambrian system. This is explained by the fact that it was a time of restricted seas and expanded deposition of continental and volcanic deposits. These presumably lacked the kind and quantity of organic material to yield the hydrocarbons necessary to form commercial quantities of petroleum in the areas of the present land masses. The neritic belt in which the proper balance of highly organic marine sediments interfingered with coarse clastics to produce both source and reservoir rocks was, for the most part, during Triassic time, outside the margins of the present continents. Nevertheless, Triassic or Permo-Triassic strata have produced small quantities of oil in the Rocky Mountain region of the United States (Moenkopi and Chugwater formations), in the Mendoza Province of Argentina and the Emba district of the U. S. S. R.

Another factor bearing on the presence of commercial oil in Triassic rocks in southwestern Alaska is the igneous activity associated with them. In the Cold Bay section, the amount of igneous rock penetrating the limestones of the Kamishak formation is unimportant, but at Ursus Cove, 180 miles to the northeast, considerably more intrusive rock is present. Possibly, the igneous activity of early Mesozoic time on the Alaska Peninsula may have been decreasing in intensity to the southwest.

The Jurassic section at Cold Bay consists of 2600 feet of dark colored shales and tuffaceous sandstones. They are considered to be a favorable association of possible source and reservoir rocks. Shales predominate near the top of the formation and would serve as a cap rock for the more porous sandstones. The absence of limestones as a potential source rock in the Jurassic is to be noted, but this deficiency may be, in part, offset by their presence in the underlying Triassic, separated only by a gradational contact.

All of the sediments referred to the Jurassic in the Cold Bay section are assigned to the Lower Jurassic and are overlain disconformably by the basal conglomerate of the Upper Jurassic Shelikof formation. There is no positive evidence that the Kialagvik formation or equivalent strata are present in the Cold Bay section, although the upper 1300 feet of the Bidarka formation did not yield any fossils. The stratigraphic interval between the Kialagvik formation cropping out on the Wide Bay anticline and the Lower Jurassic Bidarka formation cannot be estimated. The absence of igneous rocks in the Jurassic at Cold Bay is favorable. The succession of fine and coarse grained sediments in the Triassic and Jurassic section implies an oscillating sea without important mountain building nearby.

There are several factors in the stratigraphic section exposed at Wide Bay which seem to have a bearing on the oil possibilities of the Alaska Peninsula. A careful comparison of the lithologic variations vertically within each faunal zone and subzone brings out the cyclic nature of the sedimentation. Within each time interval, the sediments laid down grade from finer or coarser-grained clastics. If this persists in the subsurface section, it would provide an alternation of potential source and reservoir rocks. The coarsest sdiments in the Kialagvik formation are the conglomerates interbedded with sandstones in the upper part of the Aleuts member. The member has an exposed thickness of 1150 feet and grades upward from shales in the lowest outcrops

to conglomerates at the top. At Fossil Bluffs on Wide Bay, there is a thin zone of limestone 575 feet above the base. This sequence of lithologic units interpreted in terms of shoreline development implies a regressing sea. As the shoreline moved closer to the Wide Bay area, coarser clastics were deposited. Conversely, during an earlier stage of the regression, the area was further off-shore where clearer waters prevailed, and the deposition of calcium carbonate would not have been masked to such an extent by the influx of clastics. Hence, limestones might be expected to comprise a larger percentage of the subsurface section than is present in the exposed part of the Kialagvik formation. This is supported by the repeated record of stringers of impure limestone in calcareous shale throughout the lower half of the log of Standard Grammar Well No. 1, in strata included in the Kialagvik by the Company's geologists. This well was located in the Kanatak District, 30 miles northeast of the sections measured at Wide Bay.

The Kialagvik formation on the Iniskin-Chinitna peninsula increases in coarseness from the base upward. The lower 1600 feet is chiefly sandy shale and siltstone with some sandstone stringers. The upper 900 feet consists of sandstones with numerous thick beds of cobble conglomerates derived largely from volcanic rocks. The sequence here confirms the evidence of a regressing sea and the approach of the shoreline. The coarse conglomerates suggest that this regression was accompanied by orogenic disturbances nearby, but there is no evidence of angular unconformity between the Kialagvik and the overlying Tuxedni sandstone.

The Tuxedni standstone is a series of alternating sandstones and sandy shales. The sandstones become thicker and coarser in the upper part of the section and there are several thick beds of boulder conglomerates present. The boulders in some of these are coarse granites evidently derived from the erosion of an intrusive mass brought to the surface by uplift and degradation. The beginning of Tuxedni deposition records a new transgression of the sea in Middle Jurassic time, followed by oscillations of the shoreline as deposition and erosion contended for the littoral zone. Following the initial invasion, the record is one of halting withdrawal throughout the remainder of Middle Jurassic time. The thickness of the Tuxedni sandstone indicates a subsidence of over 4000 feet in the Iniskin Chinitna Peninsula area, but the deposition of clastics kept pace with it and the sea remained shallow

throughout the period. When subsidence ceased, permanent deposition came to an end.

At Wide Bay, the Middle Jurassic Tuxedni sandstone is not present and the Upper Jurassic Shelikof formation rests on the Lower Jurassic Kialagvik without apparent unconformity. Evidently, there was little or no subsidence in the Wide Bay area during Middle Jurassic time. It began again in early Upper Jurassic time and the Shelikof sea transgressed a long distance west of the Wide Bay area where fine clays and limes were deposited. The influx of clastics from a rising land area on the northwest soon pushed the shoreline eastward in spite of several thousand feet of subsidence during the early Upper Jurassic time. The middle part of the Shelikof formation consists of sandstones and siltstones.

The Chinitna shale, which overlies the Tuxedni sandstone on the Iniskin-Chinitna Peninsula, is in part equivalent to the lower shales of the Shelikof formation and, like it, records a period of marine transgression. The overlying Naknek sandstone shows another influx of great quantities of sands, from the adjacent land-mass. These accumulated as rapidly as the subsiding sea bottom permitted their permanent deposition. The thick bed of coarse conglomerate widely present at its base records the sudden uplift which accompanied the withdrawal of the sea after the Chinitna-Lower Shelikof transgression.

The depositional record of Jurassic time in southwestern Alaska is one of great subsidence in the neritic belt, accompanied by oscillation of the shoreline. The subsidence here was balanced by uplift of the land area to the northwest contributing coarse clastics to the eastward flowing streams. Igneous activity accompanying this orogeny is reflected in the Arkosic sandstones throughout the section and the cobbles and boulders of volcanic and intrusive rocks at many horizons. The correlation of Jurassic formations and faunas of southwestern Alaska with those of Canada and the western United States is shown in TABLE 2.

TABLE 2
CORRELATION CHART OF JURASSIC FORMATIONS AND

PERIOD	EUROPEAN STAGE	AGE IN BUCKMAN'S CLASSIFICATION (AFTER McLEARN)	WIDE BAY AND COLD BAY ALASKA	FAUNAS OF SOUTH-WESTERN ALASKA
UPPER JURASSIC			Naknek SS	Aucella
	Argovian			Cardioceras
			Shelikof Fm.	
				Astarte sp. E
	Callovian	Propanulitan		Cadoceras
				Seymourites
			HIATUS	Micrococephalites
		Macrocephalitan		
MIDDLE JURASSIC				
		Stephanoceras		
		Sonninian		Oppelia sp. C
				Defonticeras sp. B
				Zemistephanus
		Hildoceratan	Kialagvik Fm.	Dactylioceras
LOWER JURASSIC	Toarcian			"Hammatoceras"
			Bidarka Fm. ?	Arieticeras ? ?
	Sinemurian			

FAUNAS IN SOUTHWESTERN ALASKA, CANADA AND OREGON

IKISKIN-CHINITNA PENINSULA	FAUNAS OF PACIFIC COAST OF CANADA		FAUNAS OF FERNIE FORMATION OF CANADA	OREGON
Naknek SS.				?
			Cardioceras canadense	Lonesome Fm.
			Peltoceras occidentale	
				?
Chinitna Sh.				Trowbridge Group
	Yakounites	YAKOUN	Seymourites	
			Corbula munda	
	Toricelliceras			
			Chlamys meconnelli	
	Taloceras		Peloceras, Stemmatoceras, Defonticeras, Saxitoniceras, Zemistephanus	Izee Group
Tuxedni SS.				
	Defonticeras			
	Zemistephanus; Kanastephanus			Colpitts Group
			Sonninia	
?				
Kialagvik Fm.	"Dactylioceras"	MAUDE	Dactylioceras; Nannatoceras	
			Grammoceras	Howich Group
	"Sequiniceras"			Donovan Group
	"Oxynoticeras"			
			Kparniceras	

SECTION OF BIOLOGY

MAY 14, 1945

DOCTOR F. S. KISER and DOCTOR J. S. ZELLAT, Lederle Laboratories, Pearl River, N. Y.: *Antibiotics, Other than Penicillin, Produced by Penicillia.* (This lecture was illustrated with lantern slides.)

Since it was evident, from the beginning, that penicillin would be ineffective against a large number of microorganisms, particularly the Gram negative bacteria which are the cause of such diseases as typhoid fever, cholera, undulant fever, bacillary dysentery and plague, many microbiologists turned their attention to seeking other antibodies which would be effective in treating these diseases.

The search for these substances has, by no means, been limited to the *Penicillia,* but has included a great portion of the plant kingdom, and antibiotic substances have been demonstrated from such diverse sources as onion juice and the extracted growth of *Cheatomium,* a saprophytic soil fungus. Most of these substances, however, have been either too toxic for medical use, ineffective in the animal body, or only weakly antibiotic. The *Penicillia* have yielded a number of compounds, all of which fall into one or another of the above categories, but which, nevertheless, are of interest for various reasons. It is with these substances that this talk is concerned.

The search for antibiotic substances among the *Penicillia* consists of three steps: First, a rapid, qualitative test of large numbers of cultures for any degree of antibiotic activity; second, the production of a suitably high concentration of the substance in a medium from which it may be extracted and purified; and third, the isolation and purification of the substance, its identification, if it is a known compound, or the testing of the compound for toxicity and, finally, for ability to protect animals against infection and cure them after infection.

The first of these steps, the testing of large numbers of cultures for antibiotic activity, may be satisfactorily conducted by growing a single colony of the mold on a suitable medium on a Petri plate and streaking the test organism from the edge of the plate to the colony. This method permits the use of several test organisms and the testing of the same culture at several times for antibiotic activity, since it is known that some antibiotics may be produced, then later destroyed, in the medium.

The medium used must be suitable, not only for the growth of the

mold and the production of an antibiotic, two conditions, which may differ widely; but also for the growth of several different kinds of bacteria.

A suitable medium for this purpose is a 1% peptone, 0.5% meat extract, medium + 0.3% K_2HPO and 2% sucrose.

The organisms commonly used comprise both Gram positive and Gram negative species. *Escherichia coli, Staphylococcus aureus, Bacillus subtilis* and *Eberthella typhosa* are used commonly.

A loopful of a spore suspension of the culture to be tested is placed in the center of the plate and the plate incubated at about 23°–24° C. for 5–7 days, depending on the culture. The plate is then streaked from the edge of the plate to the edge of the colony with each test culture, and the plates are further incubated at 37° C. for 24 hours when they are observed for growth of the test organisms. They are then replaced in the 24° C. incubator for 5–7 days, retested, and sometimes even tested after a third period of incubation.

After a culture is found to have antibiotic activity, the next step is to produce the substance in a concentration and in a medium from which it may be extracted and purified.

Since the antibiotic may not be produced in a liquid medium of the same composition as the agar on which it was originally found, it is advisable to test a number of media. Some media commonly used are those of Raulin-Thom and the Czapek-Dox medium. These may be supplemented with various materials, such as apple juice concentrate, malt extract, beet molasses, corn steep liquor, asparagus press juice concentrate, soy bean meal, etc. Yeast extract, a favorite source of nutrilites for bacteria, has proven disappointing as an accessory substance to stimulate antibiotic production. It is also advisable to incubate a duplicate set of cultures on a shaker, since some antibiotics are produced in higher concentration in shaken cultures than in still, i.e. surface, cultures. The problem of assaying these mold cultures for antibiotic activity can be met in several ways. A commonly used method is to incorporate a sample of the culture fluid into a suitable medium, either a broth or an agar medium. Serial dilutions are made in this medium. In the case of a broth medium, only a single organism can be used per tube of medium; thus, the agar has an advantage, since it may be poured into a Petri plate and a streak inoculation made with each of several organisms. This provides an estimate of the relative sensitivity of the various test organisms for the antibiotic. This

bacterial spectrum, as Waksman has termed it, is of great importance in identifying the substance, since each of the known antibiotics has a quite characteristic bacterial spectrum. This will be further discussed in connection with each substance. It is not always necessary to sterilize the sample of culture fluid used, since the assay is usually carried out at 37° C. and the mold may not grow enough during the incubation at that temperature to interfere with the reading of the results. Furthermore, sterilization of the sample often presents a real problem since many antibiotics, notably penicillin and gliotoxin are heat-labile, while others, like streptomycin, are adsorbed to some extent by ordinary methods of filtration. It may sometimes be practical to combine centrifugation and pasteurization with some antibiotics.

Once a suitable medium and method of producing a high concentration of activity has been obtained, a relatively large batch of medium is prepared, usually twenty to fifty liters. This is distributed in amounts of approximately 250 ml. per flask in suitable flasks, inoculated and incubated for several days, when samples are taken for assay. When these assays reveal a relatively high concentration of the antibiotic, the fluid is harvested. Here the real problem begins, for the isolation, purification and identification of the antibiotic is often a laborious and time consuming process, and, since it differs with each substance, it is, perhaps, best to take up these methods in the discussion of the individual antibiotics.

Eight separate identified antibiotics have already been reported as being produced by *Penicillia*. The structural formula of four of these, clavacin, penicillic acid, citrinin, spinulosin has been determined. Puberulic and puberulonic acids and penicillin and penatin are still unknown.

Clavacin

Of all the antibiotics, other than penicillin, so far described as being produced by *Penicillia*, the most interesting is clavacin. This substance has been isolated from a number of *Penicillium* species and has been given a variety of names. It is the claviformin from *P. claviforme* of Chain *et al.*, the patulin from *P. patulum* of Raistrick, and, like most of the other antibiotics, it has also been isolated from other genera. In fact, the name most commonly used in this country, clavacin, is derived from *Aspergillus clavatus*, the species used by Dr. Waksman in his first work with it. Clavacin is a very powerful and versa-

tile antibiotic, but, unfortunately, it is also very toxic. Nevertheless, it has received considerable study in the hope that, since its structure is known, the toxicity might be modified without destroying its effectiveness as a bacteriostatic and bactericidal agent. Raistrick first published the structure of clavacin, which is known as patulin in England, in the Lancet, in November, 1943.[1] Chemically, it is anhydro-3-hydroxy-methylene-tetrahydro-γ-pyrone-2 carboxylic acid. In our experiments, it was the only antibiotic produced in all the media used. It produced a comparatively high titer against all the test organisms and no difficulty was encountered in preparing large batches of active filtrate.

The filtrate was reduced in volume *in vacuo* to about 1/20th the original, then continuously extracted with ether for 24 hours. The ether extract was concentrated and set in the chill room at 5° C. overnight, when large quantities of fine white crystals had precipitated. This material was filtered off, recrystallized from ether, and the melting point and chemical composition determined.

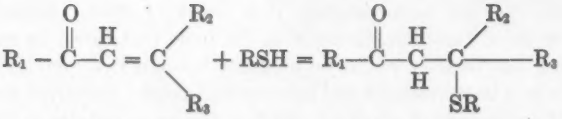
m. p. 109°

C = 54.37, H = 4.27

These values compare well with the melting point 109–110° C. uncorrected and analysis C 54.58, H 4.28% of the St. Louis University Medical School Group[2] and with the theoretical for $C_7H_6O_4$; C = 54.54, H = 3.90%.

Since the results of our *in vitro* tests and chemical tests were similar to those of Raistrick, Hooper and others, we did not, at this time, carry out extensive degradation processes for the identification of the product but did do some toxicity tests. 0.2 mg., intraperitoneally, was the LD_{100} for 20 gm. mice. The value for similar tests by the St. Louis group was 0.1 mg. The most striking symptom of toxicity with this substance is the terrific edema, resulting in hemoconcentration. This is so great that, upon death of the animal, the lungs may be filled with fluid to the point where they will not float.

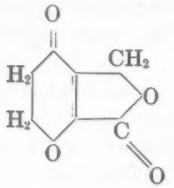
The mode of action of clavacin has been the subject of considerable study and Geiger and Conn[3] have suggested that it may be due to the inactivation of sulfhydryl groups. The exact process is unknown, but it is known that clavacin is an α-β-unsaturated ketone which will react with cysteine, thioglycollate or glutathione and, thereupon, loses its bacteriostatic activity. The reaction postulated by Posner is as follows:



If this is actually the mechanism of the reaction, it would be easy to understand the extreme toxicity of the compound, because of the known requirements of many organisms for sulfhydryl groups, but it leaves unexplained the vast difference in toxicity between clavacin and penicillic acid, which also reacts with and is inactivated by sulfhydryl groups.

The active α-β unsaturated ketones are characterized by the fact that R_1 is an aromatic group, such as the phenyl group, and either R_2 or R_3 is an H group. Clavacin, but not penicillic acid, is inactivated by thiosulfate. Acrylophenone, benzalacetophenone and furfuralacetophenone were active bacteriostatic agents, but only acrylophenone reacted with the sulfhydryls.

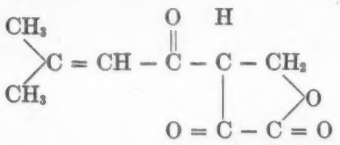
The problem of the synthesis of clavacin has been studied in a number of laboratories and recently Peutzer, Nield and Barry[4] have published the synthesis of a clavacin isomer.



Compound I

This substance was reported as showing a slight bacteriostatic activity *in vitro* against *Staphylococcus aureus* at a 1:2000 dilution. They also state that Compound I absorbs only 1 mole of hydrogen under conditions under which clavacin absorbs from 3–4 moles. The double bond in the pyrone ring is not saturated, as in the case of clavacin. This would seem to disprove the suggestion of Bergel *et al.* that a dynamic tautomerism exists between clavacin and Compound I.

They also reported that



Compound II

a compound formed by the opening of the pyrone ring of the dimethyl homologue of clavacin, had bacteriostatic activity in a dilution of 1:4000. No mention is made of inactivation of this compound by sulfhydryl groups, i.e., whether it gave a positive nitroprusside test after treatment with — SH compounds, but it should be pointed out that this compound is also an α-β unsaturated ketone.

Penicillic Acid

This substance was originally isolated in 1913 by Alsburg and Black from a culture of *Penicillium puberulum* Bainier.[5] It has since been described from *P. cyclopium* Westling by Birkinshaw, Oxford and Raistrick[6] and from *P. Thomii* and *P. suavolens* by Karow, Woodruff and Foster.[7]

It is active against both Gram positive and Gram negative organisms in concentrations from three to ten times as great as the concentrations of clavacin required for the same organism under the same conditions. However, it is much less toxic, so is of some interest.

It was produced in Raulin-Thom medium. The medium was concentrated *in vacuo* to about 1/20 the original volume and continuously extracted with ether for 48 hours. The ether extract was further concentrated *in vacuo* and set in the chill room overnight. A large quantity of crystals had precipitated. They were recrystallized from petroleum ether and the melting point and analysis were done. The melting point 81–84° C. compares well with the values reported by Raistrick, 86° C. for the anhydrous acid and the composition: C = 56.42, H = 5.85 is nearly identical with the theoretical value for $C_8H_{10}O_4$, i.e., C 56.44 and H 5.93. The bacteriostatic activity of penicillic acid compared with that for clavacin was as follows:

TABLE 1
BACTERIOSTATIC CONCENTRATIONS, mg %

	Penicillic acid	Clavacin
Salmonella pullorum	10	0.5
Brucella abortus Strain 19	20	0.65
Eberthella typhosa	15	1.25
Vibrio cholerae	15	1.25
Shigella dysenteriae	25	1.25
Pasteurella bubalseptica	10	0.65
Shigella gallinarum	15	1.25
Escherichia coli	>25	2.5
Salmonella cholera-suis	20	2.5
Staphylococcus aureus	20	1.25
Streptococcus hemolyticus	10	<0.5
Bacillus subtilis	25	5.0

The toxicity level was determined in 12 day chick embryos to be 1.5 mg. as LD_{50}. The material was injected into the allantoic cavity. Oxford, Raistrick and Smith gave 300 gm/kg as the lethal subcutaneous dose in 20 gm. mice.

Spinulosin

Spinulosin, 3,6 dihydroxy, 4 methoxytoluquinone, was first isolated from *Penicillium spinulosum* Thom by Birkinshaw and Raistrick in 1931.[8] The structure was confirmed by synthesis.

Spinulosin is only weakly antibiotic being effective against *Staphylococcus aureus* in a dilution of about 1:6000. It is almost equally effective, however, against Gram negative bacteria. It is further of interest, because a closely related substance, fumigatin, was isolated by Anslow and Raistrick from filtrates of *Aspergillus fumigatus* Fresenius cultures. This substance, whose structure has also been confirmed by synthesis, is 3 hydroxy, 4 methoxy toluquinone. These investigators found that not all strains of *Aspergillus fumigatus* produced fumigatin but that spinulosin was produced by some. Following the lead provided by the substances produced by these two organisms, Raistrick's group synthesized and tested a number of substituted benzoquinones and toluquinones. P-benzoquinone is, itself, a fairly potent anti-bacterial substance, capable of completely inhibiting growth of *Staphylococcus aureus* for 24 hours in glucose broth at a dilution of 1:12000. Its activity is diminished by preliminary incubation in glucose broth at 37°, as is the activity of all of the toluquinones and benzoquinones.

Two other toluquinones which have been found to be actively bacteriostatic are 4 methoxy and 4:6 dimethoxytoluquinone. The first of these will inhibit *Staphylococcus aureus* at a dilution of 1:300,000 for 24 hours. The dimethoxy compound is even more effective, since it inhibits the *Staphylococcus* at a dilution of 1:500,000. It might be pointed out, at this time, that the activity of the toluquinones seems to be connected with the methoxy groups and that hydroxy groups reduce the activity. Thus, spinulosin, the 3,6 dihydroxy monomethoxy compound, is less active than fumigatin, the 3 hydroxy monomethoxy compound, which is, in turn, less active than the unsubstituted monomethoxy toluquinone, while the dimethoxy compound is most active of all. Unfortunately, the toxicity of the compounds increases in the same order and the 4,6 dimethoxytoluquinone is too toxic to be of any

therapeutic value. Moreover, a protection test reported by Miss Barber, in which mice were inoculated with *Streptococcus pyogenes*, then treated with 4,6 dimethoxytoluquinone, showed no protection.

Penatin

Penatin, first described by Kocholaty,[9] is not an antibiotic in the true sense of the word, since it achieves its effect indirectly by a catalytic action, rather than by any intrinsic properties of its own. It is an enzyme, specifically a glucose dehydrogenase, and its antibacterial activity is due to the formation of hydrogen peroxide. The reaction is as follows:

$$\text{Glucose} + H_2O + O_2 \rightarrow \text{Gluconic acid} + H_2O_2$$

Since the antibacterial action is actually due to hydrogen peroxide rather than to the enzyme, the range of activity is wide and includes both aerobes and anaerobes, Gram positive and Gram negative forms.

Kocholaty adsorbed the material on kaolin at an acid pH, eluted with pyridine, precipitated with dioxane and, finally, took it up in water. The St. Louis group[10] used a much simpler method involving precipitation with uranium acetate and liberation with phosphate at pH 6.8. The enzyme is then salted out with ammonium sulfate, dialyzed to get rid of the sulfate, and lyophilized. Recovery of activity is practically complete.

The prosthetic group of the enzyme isolated by the St. Louis group was shown to be flavine adenine dinucleotide. Their preparation differed somewhat from that of the group at the London School of Hygiene & Tropical Medicine who referred to their substance as notatin. This difference might be due to a slight difference in the enzyme. The glucose dehydrogenase, isolated at this laboratory, was essentially the same in its action as that reported by the St. Louis group. It has been shown that the antibacterial activity is wholly accounted for by the hydrogen peroxide produced. Gluconic acid will prevent the growth of *Staphylococcus aureus* in a 1:1000 concentration in a peptone-glucose medium, but this concentration lowers the pH to 4.2. Inhibitory concentrations of penatin do not depress the pH below 6.2, which is not, in itself, inhibitory. The concentration of the enzyme, as well as that of the glucose, effects the amount of the hydrogen peroxide formed and therefore the amount of antibacterial activity exhibited by the preparation. Catalase completely destroys the activity of the

substance and, of course, fresh unheated serum also decreases or destroys the activity, though old, or heated serum will cause little or no decrease in antibacterial activity. The enzyme, itself, is not inactivated by potassium cyanide, so it is possible to mix the enzyme with a mixture of 0.1 M KCN and catalase, which is inactivated by the cyanide, and have the preparation retain full activity. Moreover, the antibacterial effect may be destroyed by any chemical means which will destroy a corresponding amount of hydrogen peroxide. These include the addition of ferrous salts, cysteine, and sodium thiosulfate.

A few toxicity and protection tests were run on this substance. Kocholaty reported that 500 mg., intramuscularly, or 20 mg. per day for five days was not toxic to guinea pigs, but other workers found the toxicity of their preparations to be much greater. No protective effects have been reported. This substance is of importance because it may simulate an active antibiotic. It can be rather easily ruled out, however, by a few simple tests. First, is the substance active in glucose free media? In this connection, one should not overlook the fact that glucose may be carried over in the filtrate sample and even 0.005% of glucose may produce significant amounts of hydrogen peroxide. However, if the material is significantly more active in a glucose containing medium than in one lacking glucose, the effect of catalase or of fresh serum upon the activity should be determined. If the activity is greatly decreased or destroyed, two other simple tests may be applied. Precipitation with uranium acetate and elution with phosphate at pH 6.8 plus failure to dialyse can be considered pretty conclusive evidence that the substance in question is a glucose dehydrogenase.

Citrinin

First isolated in 1931 by Hetherington and Raistrick[11] from a culture of *Penicillium citrinin* Thom, it is probably the easiest of the antibiotics to prepare, since it is only necessary to acidify the filtered culture in order to precipitate the yellow microcrystalline compound. The precipitate is filtered, washed and recrystallized from boiling absolute ethanol.

Citrinin is principally effective against Gram positive bacteria which it inhibits in high diluton. It has not proven to have any *in vivo* activity, though it is not excessively toxic.

Puberulic and Puberulonic Acids

These substances are found in small amounts in cultures of *Penicillium puberulum.*[12] Puberulic acid is a practically colorless dibasic acid which is bacteriostatic for Gram positive bacteria in low concentrations. Puberulonic acid, which is bright yellow, is a much less active bacteriostatic substance. No reports on toxicity or protective action have appeared.

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SECTION OF PSYCHOLOGY

MAY 21, 1945

DOCTOR MORRIS S. VITELES, Professor of Psychology, University of Pennsylvania, Philadelphia, Pa.; Chairman, National Research Council Committee on Selection and Training of Aircraft Pilots: *Research in Aviation Psychology.* (This lecture was illustrated by lantern slides.)

In 1939, the Civil Aeronautics Authority (now the Civil Aeronautics Administration) undertook an ambitious program of training civilian pilots. The purpose of this was to make young men and young women airminded and to prepare the present generation of young people to fly the private and commercial planes of the future. This program, known as the Civilian Pilot Training Program, was operated through the universities of the country, making use of already established facilities in the hands of private operators while encouraging others to set up similar facilities.

The first phase of the Civilian Pilot Training Program called for instruction of 10,000 pilots, which was quickly expanded to the number of 50,000. Almost simultaneously with the formulation of the program, largely through the efforts of Robert Hinckley, at that time Chairman of the Civil Aeronautics Authority, and Dean R. Brimhall, Director of Research, funds were set aside for research on selection and training of civilian aircraft pilots. This was done in the belief that an extended program of civilian pilot training should make use of every possible scientific aid for selecting those most competent to fly; for determining the best methods of training; for the appraisal of flight achievement; and for safeguarding the adjustment of the pilot. Moreover, it was recognized that this large scale training program provided unusual opportunities for renewing the study of problems related to the human side of aviation which had been initiated during World War I and abandoned almost immediately with the signing of the Armistice.

The National Research Council was asked to undertake the responsibility for administering these research funds, and a committee, known as the Committee on Selection and Training of Civilian Aircraft Pilots, with J. G. Jenkins as Chairman, was set up to organize and supervise the research program. This committee, which includes psy-

chologists, physiologists, physicians, and engineers, has been in continuous operation since 1939, and, through a small Executive Subcommittee, has conducted research in aviation psychology involving the expenditure of well over three-quarters of a million dollars. Early in 1941—with some foresight—the word "civilian" was dropped from the name of the Committee, and close liaison was established with military services who nominated representatives to become members of the Executive Subcommittee. Since that time, the work of the Executive Subcommittee has been conducted in close association with the Army and Navy and many of the results of the Committee research have been applied by the Services.

As in the application of psychology in similar situations, such as in industry or education, the research program of aviation psychology has been organized around the three basic functions of selection, training, and maintenance of personnel.

Since the first objective of the initial phase of the pilot training program was to build up a large pool of competent pilots, it was natural to start research with investigations bearing on the problem of selecting, from a random group of applicants, those men who were particularly qualified to learn to fly. Investigations were undertaken simultaneously in many university centers where civilian pilot training programs were under way. In addition, in cooperation with the Navy, the Committee had an opportunity to make a highly extensive study at a Naval training station where approximately 800 aviation cadets and instructors were available as subjects.[1] In this investigation, a very large number of psychological tests, both of the paper-and-pencil and of the psychomotor type; a large variety of physiological tests, including the tilt-table, the electrocardiogram, electroencephalogram and others; and, in addition, the personal interview was subjected to experimental study. Concurrently, individual predictors were subjected to intensive studies at other centers and, later, integrated projects involving the examination of civilian pilot trainees at Boston and in the Midwest area were employed to check the findings of earlier investigations.

In the area of psychological tests, it was found that two easily administered paper-and-pencil tests could effectively be used in reducing the proportion of failures in the primary phase of pilot training. These included a standard mental alertness test and a biographical informa-

tion blank through which the interests, the family background, the occupational experience, and avocational activities of the candidate were explored. Later work, done both by the Committee and the Navy, showed that still a third test—a test of mechanical comprehension—could be usefully added to the battery. While it is not permissible to state the reduction in failures accomplished through the use of these tests—because this is still classified information—it is possible to say that the results were sufficiently good to lead the U. S. Navy to adopt these as the basic instruments for the selection of Naval Aviation Cadets.

Repeated studies on larger and larger samplings in the Navy gave repeated verification that the test results did bear a direct relation to the prediction of success in learning to fly at the primary level, and while changes have been made in the way of developing new forms of these tests, the research initiated by the Committee on Selection and Training of Aircraft Pilots, through the foresight of the Civil Aeronautics Administration, has furnished the backbone of the Naval Aviation Cadet selection program.

In addition to the paper-and-pencil tests, a number of psychomotor tests have proven to be extremely useful in the prediction of flying success. In passing, it should perhaps be again pointed out that flying success, as used in this address, refers to success in learning to fly the plane. So far, it has not been able to obtain the data necessary to reveal the relationship between predictors and success in the actual combat situation. However, combat data are being assembled by the military services, and it will be possible, before this war is ended, to obtain significant information on such relationships.

Psychomotor tests, which have held up for pilot selection, include a two-hand coordination test requiring coordination analogous to that of lathe operation, and an eye-hand coordination test, in which the hand is required to follow a moving visual stimulus. Among psychomotor tests which have proven to be particularly satisfactory, is one developed during the last war, the Mashburn Test, which simulates certain aspects of the task of flying, in that the subject is required to make adjustments of an airplane control stick and rudder pedal in response to visual stimuli. This test, which is essentially of the complex reaction type, when combined with the eye-hand and the two-hand coordination test, gives substantial correlation with a rigorous criterion of success in learning to fly.

Research on psychomotor instruments has been conducted, not alone by the Committee on Selection and Training of Aircraft Pilots, but also by the Army Air Forces and, somewhat in contrast to the Navy test battery, psychomotor tests are major items in the battery for the classification of personnel used by the Army Air Forces.

The selection research program of the Committee on Selection and Training of Aircraft Pilots has been eclectic in character. Since, in military, as well as in industrial situations, considerable attention has been given to the interview, it seemed well to investigate efficiency of this device in predicting the success in learning to fly. An experiment was therefore designed in which a Board of Interviewers conducted a relatively standardized interview involving the use of a carefully devised rating scale (EXHIBIT 1). Agreement among interviewers in

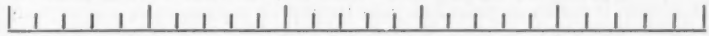
EXHIBIT 1

INTERVIEW CHART

Name of Candidate.....

Name of Rater.....

C. GENERAL SOCIAL ADJUSTMENT AS RELATED TO FLYING



25	20	15	10	5	1
ESPECIALLY WELL ADJUSTED	WELL ADJUSTED	FAIRLY WELL ADJUSTED	POORLY ADJUSTED	VERY POORLY ADJUSTED	
.. is very popular;		.. gets along well with others;	.. is a "joiner";		
.. has many friends;		.. is socially like most people;	.. is a misfit;		
.. gets along in most situations;		.. is a stay-at-home;	.. would make an ideal friend for anyone;		
.. does not get along with people;		.. antagonizes people;	.. is an excellent mixer;		
.. is a "lone wolf";		.. is very much interested in group activities	.. has antisocial tendencies;		
.. is sought out by many people			.. is out of touch with the world		

EXPLANATION OF RATING:

.....

.....

predicting success or failure proved to be quite high, mean correlations among independent interviewers in rating "Fitness for Flight Training" being close to .90 (EXHIBIT 2). The interview fared surprisingly well in predicting certain objective criteria of competence in flying. Indeed, in so far as pilot performance can be measured objectively, the

EXHIBIT 2

THE CORRELATION BETWEEN THE MEAN OF THE RATINGS FOR A GIVEN INTERVIEWER ON THE FIRST 8 SCALES AND THE OVER-ALL OR "FITNESS FOR FLIGHT TRAINING" RATING FOR EACH INTERVIEWER

School	*Rater*	r_{MI}	r_{MI}
Harvard	#1	.80	
	#2	.88	
	#3	.89	
	All Three Raters		.86
Ohio	#1	.90	
	#2	.93	
	#3	.88	
	All Three Raters		.90
Purdue	#1	.86	
	#2	.84	
	#3	.85	
	All Three Raters		.83
Michigan	#1	.89	
	#2	.93	
	#3	.90	
	All Three Raters		.91

interview reached levels of prediction which are accepted as having practical significance.[2]

The interview met the routine tests of scientific acceptability. However, it failed of practical justification on a most basic and critical point. The interview, a technique which requires the services of several individuals to obtain a rating for one individual at a time, is very expensive with regard to time, personnel, and money. To be accepted as having practical usefulness in selecting pilots, it must add significantly to the predictive efficiency that is obtainable by the application of pencil-and-paper tests to whole groups at a time. The interview failed to do this.

Using the paper-and-pencil tests, to which reference has been made, predictions can be made for 500 men with a total time expenditure of about 2 to 10 man-hours. Adding an individual interview to this prediction does not materially increase the efficiency of prediction, although it adds at least 750 man-hours to the time expended. Thus, although the interview shows promise of achieving useful levels of reliability and validity in the selection of pilots, its failure to add to the prediction obtainable by group techniques indicates that its excessive cost in time and money was proven to be not justifiable. Considering, for example, the fact that one Committee project[3] involved the examination, for the Civil Aeronautics Administration, of 67,000 applicants for flight training in 570 centers throughout the United States, it can

be seen that such findings have great practical and economic significance.

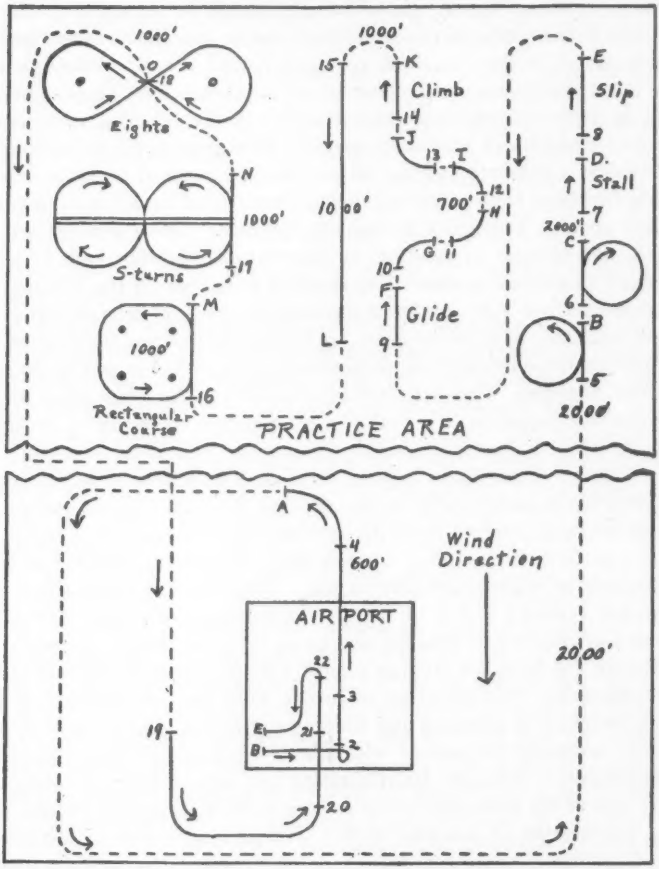
Individual physiological measures used in Committee investigations proved to be generally unpromising in the selection of pilots. For example, less than 1% of Naval Aviators revealed electroencephalograms which could be described as detrimental, indicating that whatever is measured by the electroencephalogram is, somehow or other, covered in the course of the established routine examinations and interviews given in the course of selecting Naval aviators. Results for the electrocardiogram and measures of aniseikonia were likewise negative in terms of practical considerations in the selection of aircraft pilots. Respiratory and cardiovascular measures proved to be largely unreliable, apparently giving, in the main, biological instants of organic functions rather than consistent measures of such functions to be relied upon as predictors of flight proficiency. These findings are of particular interest in relation to observations showing lack of consistency in medical examinations reported in studies for the Division of Research, Civil Aeronautics Administration, made independently of the Committee research program, by D. R. Brimhall and R. Franzen.[4, 5] Work continues in this area, particularly in the development of physiological measures with satisfactory reliability. An evaluation of 23 respiratory measures, for example, showed five measures to be sufficiently reliable for experimental comparison with flight success.[6]

Because of the basic importance of such standards of achievement in aviation research, early in the research program of the Committee, attention was centered upon the development of acceptable criteria of flight performance. Initial studies were, of course, centered on the adequacy of criteria actually in use. These studies showed that instructor ratings; scores on final examinations by inspectors; daily grades on flight performance and even, to some extent, the pass-fail criterion (at least for civilian pilots) were not of sufficient reliability or sufficiently discriminating to justify their use for research on the relative value of selection and training techniques. As a result, it was found necessary to proceed with the development of more objective, more reliable, and more discriminating measures of flight performance.

One of the first steps in the development of acceptable criteria was the preparation of *standard flights,* so that observation or recordings of flight performance could be made under essentially uniform conditions. A series of such flights, suitable for use at various levels of the

primary training course, was developed in research conducted at the University of Pennsylvania by the speaker with the assistance of Dr.

EXHIBIT 3
STANDARD FLIGHT D
(for use at Boston Metropolitan Airport, Norwood, Mass. and Muller Field, Revere, Mass.)



November 20, 1941

Prepared by: Morris S. Viteles
Albert S. Thompson
Univ. of Penna.

A. S. Thompson of the Department of Psychology.[7] Such flights represent a "work sample" which calls for prescribed maneuvers to be carried through in a definite order and under stated conditions of wind velocity, etc. When standard flights are used it becomes possible to compare the flight proficiency of one individual with that of others, since all are required to perform the same maneuvers under essentially the same conditions.

EXHIBIT 3, Standard Flight D, describes a flight suitable for use in observing the performance of student pilots nearing the completion of the final stage in the C. P. T. primary program. It includes the more advanced maneuvers such as 360° turns, figure 8's, rectangular course, 180° approach to landing, etc. It is to be noted that the maneuvers included in these flights are of two types, *"critical maneuvers"* (indicated by solid lines), and *"transition maneuvers"* (indicated by dotted lines). Each transition maneuver is designed to put the plane into position for the succeeding critical maneuver. The transition maneuvers can be changed so as to adapt the flight to any level or type of civilian or military training program and to any airport.

With standardization of the situation under which the pilot's performance is evaluated, it became possible to take steps towards the improvement and objectification of criteria of achievement in learning to fly. The general character and reliability of direct observations of

EXHIBIT 4

CLIMBING TURN

CONTROL USE	Entry	Turn	Recovery
SIMULTANEOUS	☒	☐	☒
Successive	☐	☒	☐
Slips	☒	☒	☐
Skids	☐	☐	☐
NEITHER	☐	☐	☒
Rudder Pressure:			
CORRECT	☐	☐	☒
Incorrect	☒	☒	☐

PRECISION

Bank: CONSTANT... ☒

Varies.....—°

Speed.....55 MPH

CORRECT Climbing Speed reading is.....53 MPH

CONSTANT... ☐

Speed is

Varies..... 3 MPH

flight performance, by instructors or inspectors actually in the plane with the students, were improved by providing specially designed forms calling for ratings on specific aspects of flight performance. A portion of one such form, *"The Ohio State Flight Inventory"* prepared by H. A. Edgerton and R. Y. Walker,[8] is illustrated in EXHIBIT 4.

Considerable work was done at Tulane University and at the University of Pennsylvania in analyzing the possibilities of commercial graphic instruments which provided a record of control movements and of changes in the attitude of the plane during flight.[9] Commercial recorders were found unsuitable, but the study led to the development of specifications for the construction of a new flight recorder which provides a graphic record of skids and slips; of changes in altitude; of variations in air speed; and of control movements associated with changes in plane attitude.

Perhaps the most significant development in the way of techniques for recording and evaluating flight performance has taken the form of a motion picture camera mounted in the plane to provide records for analysis on the ground. Problems of photographic recording were attacked independently at the University of Rochester and at the University of Pennsylvania.[10] While the Rochester project, with the cooperation of the Director of Research, CAA, proceeded immediately to the development of a concealed photographic unit, including an instrument panel and control movement indicator, the Pennsylvania group, in its earlier studies, photographed directly the plane instrument panel and the actual manipulation of controls by the pilot.

Present installations, adapted with the aid of the staff of the Institute of Aviation Psychology, University of Tennessee, provide for photography of an instrument panel containing flight instruments and a control movement recorder located in the baggage compartment of the plane. Both the photographic installation and methods of analyzing photographic records developed in research at the University of Pennsylvania have been widely used in obtaining objective criterion data in Committee research projects.

Graphic and photographic records and associated methods of analysis do not yield direct measures of certain aspects of pilot performance, such as observance of safety precautions, use of certain types of judgment, etc. They yield measures primarily of value in analyzing the skill displayed in the execution of maneuvers and are particularly useful in research where detailed and objective information on

the level of skill exhibited by the pilot is desired. Because of these objectives, graphic and photographic records provide basic data for determining the reliability of a single test flight, and in selecting, for pilot assessment, those aspects of flight performance which are relatively stable from flight to flight. It is also possible that graphic and photographic methods could be used for diagnosing specific faults of students who have difficulty in learning to fly, in much the same way as motion photographs are currently employed in the analysis of the faults made by members of football teams during actual play.

As the selection program has become stabilized, and improved criteria for the measurement of pilot performance have become available, it has been possible for the Committee on Selection and Training of Aircraft Pilots to center increasing attention upon the very important problem of improved methods for training pilots. Research in this area has, without question, placed the United States in the forefront of all nations in the matter of an experimental attack upon the problems of learning and teaching in aviation.

The Committee went about the job of research in pilot training in a very practical way. It started by finding out just what flight instructors actually did and said in teaching pilots. Discussions with both flight instructors and students showed that there were wide variations in instructional practices. However, nobody had had an opportunity to observe directly how the instructor went about the job of training pilots, especially in the primary and secondary phases of instruction, since observers could not be carried in the two-place planes used for such instruction. It was therefore found necessary, as a first step in research on training, to develop methods for listening in on conversations between an instructor and student during training flights and for recording such conversations. This was done by E. L. Kelly through the construction, at Purdue University, of ground-to-air transmission and recording apparatus which made available for analysis student pilot-instructor conversations.

Such an analysis made available many interesting items about the nature of instruction in the air. Frequently, the recordings were most revealing to the instructors who, when given an opportunity to listen to their conversations, were amazed to hear just what they had said. So, for example, until he heard his recorded conversation, one instructor refused to believe that he was telling students that the airplane steered just like a "sled," when the reverse is actually the case. Another be-

came aware, for the first time, why so many of his students were failing spins in the final flight examination when he heard his voice consistently go into a high pitch of hysteria as the student went into the spin and undertook to recover.

Qualitative observations of this type proved to be extremely helpful in revealing how the instructor taught and what students went through in learning to fly. Even more interesting were the findings of the systematic analyses of flight instruction recordings. One of the most significant of these was the revelation of great variation in vocabulary or terminology from instructor to instructor. In a study made of pre-solo dual instruction of four students by four instructors, it was found that 500 technical terms or phrases were used.[11] Many of these terms were peculiar to the instructor and were used without explanation to the student. Only one-seventh of the 500 terms were used by all four instructors. Over half of them were used by only *one* of the *four* instructors. Approximately one-third of the terms used were employed only once and by only one instructor. Such terms represent not only a private language of the individual instructor, but also are rarely used by that instructor.

These and other findings, in studies by E. L. Kelly and E. S. Ewart, led to the recognition of two very real needs: (a) for a set of short, simple, uniform, descriptive study sheets describing each maneuver to be studied by the student before receiving instruction in the maneuver; and (b) for a standardized patter for use by instructors during flight instruction. There was therefore prepared, for student use, a series of study sheets known as the *"Fundamentals of Basic Flight Maneuvers"* providing a description in the simplest and most straightforward fashion of the minimum essentials of information concerning each maneuver, which should be known by the student before attempting the maneuver. Sheets are bound loose-leaf to permit an instructor to hand out the sheet covering the particular maneuver which the student will take up in his next lesson, and which he is required to review before the next session of flight instruction. This is then again gone over on the ground before the student and instructor take to the air for flight instruction.[12]

For the instructor, there was provided a little bound volume of PATTER, including a standardized statement concerning the maneuver for use during flight instruction. The PATTER substitutes uniform descriptions of the maneuvers to be performed for the vary-

ing statements made to different students, when the instructor depended more or less upon the inspiration of the moment to decide how he would go about giving instructions on the maneuver. In passing, it is interesting to note that the idea of using PATTER was borrowed from the British, but that the PATTER books developed for use in training American student pilots were unlike those used by the British, in that they were based upon a factual analysis of flight instruction, to which reference has been made.

Perhaps the best cue to the value of these manuals, derived from the experimental studies of instructional techniques, is to be found in the fact that the Committee on Selection and Training of Aircraft Pilots was asked to supply personnel to help the Navy in preparing similar manuals for use in training Naval aviation cadets, and in the additional fact that the first order for such manuals for use by the Navy called for twenty thousand of each. The preparation of PATTER for the primary course was followed by the preparation of similar materials for the secondary course, and this material has been widely used in the instructor program of the War Training Service of the Civil Aeronautics Administration, as well as in modified form by the services.

Another practical outcome of Committee research in the area of training has been to focus attention upon the need of giving pilot instructors training in how to teach. In 1943, the Committee administered for the War Training Service of the Civil Aeronautics Administration two institutes at which *methods instructors* were given an intensive and practical course in training methods based on Committee research findings.[13] In addition to receiving instruction at the Institute, methods instructors were furnished with a "kit" of demonstration materials and samples of training aids which might prove effective in their teaching. A number of synthetic training devices were also added to aid in the instruction in the field. Both the Army and the Navy have also recently established special schools for instructors at which procedures similar to those embodied in the methods instructors' manual prepared by the Committee on Selection and Training of Aircraft Pilots are being used to put psychology to work in improving the training methods employed by pilot instructors.

Research on training continues. For current research, the Committee on Selection and Training of Aircraft Pilots has available a new instrument which is proving to be an effective aid in its investigations.

This is an air-borne model of a magnetic wire recorder developed at the Armour Research Foundation, with the cooperation of E. L. Kelly, as the result of the initiative and cooperation of the Committee on Selection and Training of Aircraft Pilots and of the Division of Research of the CAA. In this air-borne instrument, conversation between pilot and instructor is recorded on a steel wire only four-thousandth of an inch in diameter. With an instrument weighing only approximately 12 lbs., it is possible to record in the air a conversation lasting for one hour on a reel of wire only approximately four inches in diameter and one inch across.

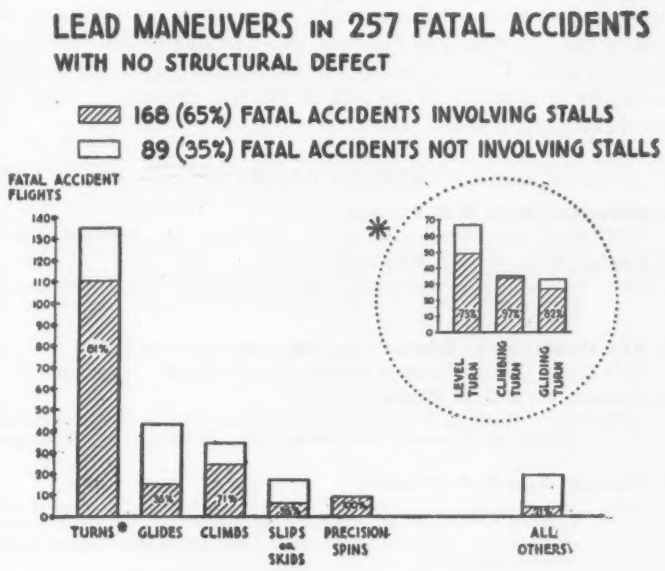
The air-borne model of the magnetic wire recorder has been used to great advantage in the current research program of the Committee on Selection and Training of Aircraft Pilots. One item in this research program involved a comparison of two groups of student pilots, one receiving instruction with the use of certain training aids and the other without the use of training aids. Photographic records of the performance of both groups during standard flights have been made, as a means of determining whether the use of the training aid makes a significant contribution to the improvement of flight proficiency. In another experiment, inspectors made check flights and recorded their observations verbally through the use of the magnetic wire recorders. Simultaneously, photographic records were made of the actual control movements of the pilot and of the attitudes assumed by the plane. In this manner, it becomes possible to determine items of plane and pilot performance which can, and those which cannot be accurately observed and reported upon by inspectors. In numerous other studies, the combination of wire recording of conversations and photographic recordings of pilot control movements and plane attitude furnishes the basis for an objective and factual analysis of what actually goes on in the plane, as a substitute for the arm chair rationalization and artificial laboratory investigations which were employed prior to the present war, in research on the human element in aviation.

As indicated earlier, Committee investigations have also been concerned with the problems of pilot maintenance and adjustment. In one such study, by D. Lewis, the effect of noise and vibration upon pilot performance has been studied. Considerable work has been done by C. Taylor and R. Franzen upon the evaluation of the Schneider Index and other standard tests of "exercise tolerance," and such investigations have suggested the possibility of substituting a more reliable

and effective measure of so-called "physical fitness," or of what might better be described as "exercise tolerance," for the existing measures.[14, 15] Considerable attention has been given to problems of motion sickness in the air in experiments by G. R. Wendt at Wesleyan University. These have led to the publication of a popular pamphlet entitled "How to Prevent Airsickness" which presents to the flight instructor and the student pilot a few simple rules which, there is reason to believe, can be effective in reducing the incidence of airsickness. The problem of tension has also been investigated in some detail.

In a major study,[16] the causes of civil aviation accidents, and the maneuvers most closely related to these accidents, are being investigated by D. R. Brimhall and R. Franzen. The extent to which fatal accidents are associated with stalls, particularly those growing out of turns at low altitudes, has suggested the necessity of important shifts of emphasis in the training program (EXHIBIT 5). A practical outcome of such research findings and conclusions would be a shift in emphasis

EXHIBIT 5



during training to the avoidance of and immediate recovery from the stall condition, possibly through extended practice in slow flying.

It is apparent from what has been said that the research interests of the Committee on Selection and Training of Aircraft Pilots have been wide and varied. They have been directed toward civilian as well as military flying. They have led to the development of tools and techniques which have received wide acceptance both in civilian pilot training and by the military services. Nevertheless, the surface has only been scratched, and there is every reason to believe that continued and extended investigations are needed for the solution of many of the real problems experienced when human beings undertake to fly bigger, faster, and different planes.

To this end, the Committee, in cooperation with the Civil Aeronautics Administration and the Tennessee Bureau of Aeronautics, has already taken steps toward the assurance of postwar research through the establishment of an Institute of Aviation Psychology at the University of Tennessee. A similar center is currently being set up at Ohio State University where the relationship between visual efficiency and flight performance will be carefully determined. In this way, the work of the Committee on Selection and Training of Aircraft Pilots, supported by the Civil Aeronautics Administration, is serving to reduce the danger of cessation of research in aviation psychology which occurred at the end of World War I.

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SECTIONS OF BIOLOGY AND PHYSICS AND CHEMISTRY

MAY 18 AND 19, 1945

Conference on *"Blood Grouping."*

The Sections of Biology and Physics and Chemistry held a Conference on "Blood Grouping," as the seventh in the series for the Academic Year 1944–1945. Doctor William C. Boyd, Boston University, School of Medicine, Boston, Massachusetts, was the Conference Chairman in charge of the meeting.

The program consisted of the following papers:

"Introduction to the Conference," by William C. Boyd.

"Isolation and Purification of Blood Group A and B Substances; Their Use in Conditioning Universal Donor Blood, in Neutralizing Anti-Rh Sera, and in the Production of Potent Grouping Sera," by Ernest Witebsky, University of Buffalo, Medical School, Buffalo, New York.

"Method for the Production of Anti-A, Anti-B and Anti-Rh Isoagglutinin Reagents: A. Choice of Plasma. B. Fractionation Process. C. Absorption and Neutralization Process. D. Standardization of Product," by J. L. Oncley, M. Melin, J. W. Cameron, D. A. Richert, L. K. Diamond, Harvard Medical School, Boston, Massachusetts.

"Recent Advances in the Immuno-Chemistry of Isohemagglutinins," by Louis Pillemer, Western Reserve University, Institute of Pathology, Cleveland, Ohio.

"Procurement and Preparation of Blood Grouping Serum," by Captain John Elliott, Army Medical School, Washington, D. C.

"The Assay of Blood Grouping Sera; Variation in Reactivity of Cells of Different Individuals Belonging to Groups A and AB," by William C. Boyd, Boston University, School of Medicine, Boston, Massachusetts.

"Genetic and Constitutional Causes of Fetal and Neonatal Morbidity," by Philip Levine, Ortho Research Foundation, Linden, New Jersey.

"The Rh Series of Allelic Genes, with Special Reference to Nomenclature," by A. S. Wiener and Eve B. Sonn, Medical Examiner's Office, New York, N. Y.

ANNOUNCEMENT OF ADDITIONAL PUBLICATIONS FOR 1945[1]

The following publications, in addition to those announced in the April number of the TRANSACTIONS, will be issued by the Academy during the current year. Members of the Academy who desire to receive these will kindly request the Executive Secretary to send them, and they will be mailed, free of charge, as they are ready for distribution, except as qualified in the footnotes:[2]

ANNALS

7. "Non-Projective Personality Tests." Papers delivered at the conference by this title. (Approximately 75 pages.)

8. "Lymph." Papers delivered at the conference by this title. (Approximately 150–200 pages.)

9. "Blood Grouping." Papers delivered at the conference by this title. (Approximately 125 pages.)

10. "The Golgi Apparatus—A Modern Interpretation," by Leonard G. Worley. (Approximately 40 pages.)

11. "Brain and Body Weight in Man: Its Antecedents in Growth and Evolution," by Earl W. Count. (Approximately 110 pages.)

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[1] Notice of any additional papers to be added to this list will be sent to Members as they are approved for publication.

[2] Active, Sustaining, Life, and Honorary Members may receive, upon request, a copy of all current numbers of the Annals.

Associate and Student Members are entitled to receive one complete monograph, or up to 150 pages of smaller papers.

NEW MEMBERS

Elected May 15, 1945

ACTIVE MEMBERS

Crowninshield, Vincent F., M.A., Psychology. Assistant to Personnel Director, Johnson and Johnson, New Brunswick, New Jersey.

Friedmann, Jechiel Moses, M.D., Psychology, Biology. Practicing Neuropsychiatrist, New York, N. Y.

Gardner, William Howlett, Ph.D., Chemist, New Products Division, National Aniline Division, Allied Chemical and Dye Corporation, New York, N. Y.

Haring, Robert C., Ph.D., Industrial Organic Chemistry. Research Chemist, National Aniline Division, Allied Chemical and Dye Corporation, New York, N. Y.

Hill, Ella C., B.S., Anthropology, Natural Sciences, Docentry. American Museum of Natural History, New York, N. Y.

Lederberg, Joshua, A.B., Cell Physiology. Student, Columbia University Medical School, New York, N. Y.

Meister, Alton, B.S., Medicine and Biochemistry. Interne in Medicine, New York Hospital, New York, N. Y.

Seigle, L. W., Ph.D., Organic Chemistry. Research Chemist, New Products Division, National Aniline Division, Allied Chemical and Dye Corporation, New York, N Y.

Watts, Nellie Perry, Ph.D., Drugs. Research Associate, Department of Therapeutics, New York University, New York, N. Y.

ASSOCIATE MEMBERS

Bartner, Elliot, B.S., Chemistry. Research Assistant, Rutgers University, New Brunswick, New Jersey.

Howard, Gerald V., B.A., Fisheries Conservation. Junior Biologist, International Pacific Salmon Fisheries Commission, New Westminster, British Columbia, Canada.